

Social Innovation Workshop: Summer school on interdisciplinary higher education through social innovation in STEM subjects

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Abstract

Promoting entrepreneurial skills and integrating social issues into STEM fields encourages creative solutions for societal challenges. However, interdisciplinary programs that incorporate social sustainability remain rare globally. A study on a social innovation summer school examined whether this format equips STEM students with the skills and mindset for active social engagement. Students appreciated the interdisciplinary exchange and practical orientation, but assessing the societal impact of their work proved challenging. The summer school raised awareness of social responsibility, highlighting the need for long-term integration of such approaches in STEM education.

Keywords

Social innovation; summer school; interdisciplinarity; STEM

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1. On the (necessary) link between engineering courses, social innovations and ESD

Global and national crises are becoming more apparent and requiring long-term thinking. Political disputes and social solutions are gaining importance in response to global crises (Müller & Schmidberger, 2022, p. 80) and especially young people show strong interest in social change (e.g. Bartels & Karic, 2023; Gaiser et al., 2016; Starcke & Dohnke, 2023). Gaiser et al. (2016) show that 16-29 year olds, mostly students and pupils are particularly interested in socio-political topics and that interest within this group increases with age (p. 18). Many young people are willing to give up personal benefits to address social problems, as revealed by a survey in Darmstadt, Germany (Starcke & Dohnke, 2023, p. 11). Moreover, 65% of the youth in the DJI study expressed a willingness to engage actively, e.g., by participating in demonstrations (Gaiser et al., 2016, p. 20). However, the reality presents a different picture from the stated willingness, revealing a clear knowledge-action gap that is partly explained by the lack of social structures for meaningful political engagement (Bartels & Karic, 2023, p. 13; Gaiser et al., 2016, p. 21).

The social innovation summer school tried to reduce the knowledge-action gap among STEM students. Empowering students to address social change and develop entrepreneurial skills is widely regarded as a

way to stimulate independent action and foster creative solutions to the social challenges future engineers will face (Alali et al., 2023, p. 14f.; Cadenas et al., 2020, p. 9; Hockerts, 2017, p. 124; Schaper, 2016, p. 8ff.). The focus is deliberately placed on STEM students, as the technical courses of study often equip them with strong problem-solving skills (Scherer & Beckmann, 2014, p. 2; Giang et al., 2024, p. 2). STEM students' problem-solving skills can also be applied to social challenges. Problem-solving competences are understood as the ability not only to solve domain-specific challenges but also to develop transferable strategies applicable to real-world contexts (Greiff et al., 2013, p. 74; Scherer & Beckmann, 2014, p. 2). Literature has recorded a significant increase in research in this area in recent years (Giang et al., 2024, p. 7). In addition to growing academic interest, STEM students themselves express a clear motivation to integrate social concerns into their studies and to use the knowledge to address global challenges (Niles et al., 2018, p. 2).

As a way to support this motivation, the present study tested the individual development of social innovation (SI), which is considered effective in initiating or supporting processes of change in society as a whole (Bormann et al., 2022, p. 52). Recent bibliometric analyses show that Education for Sustainable Development (ESD) is gaining increasing attention in research on higher education, yet implementation in STEM disciplines remains limited, and often lacks

practical integration (Halliger & Nguyen, 2020, p. 6). To clarify how SI was understood in the context of the summer school, it is helpful to distinguish it from social entrepreneurship (SE) – a term that has gained increasing attention in the literature since 2010 and is sometimes used synonymously (Rey-Martí et al., 2016, p. 1651; Saebi et al., 2019, p. 71). Neither SE nor SI have universally accepted definitions. Both aim to address social challenges (Phillips et al., 2015, p. 442). However, the goals they pursue are different.

While SE aims at material or financial profits (Phillips et al. 2015, p. 430), SI is more altruistic. SI seeks to increase societal well-being (Dawson & Daniel, 2010, p. 10). Nevertheless, innovation is invariably perceived as a collective and circular process (Dawson & Daniel 2010, p. 10; Phillips et al., 2015, p. 449). While SI can focus on obvious problems such as hunger or poverty, less visible problems such as racism or domestic violence are also possible topics (Mulgan, 2006, p. 149). The forms of SI are as diverse as the challenges they address (Mulgan, 2006, p. 150). SI does not impose on any affected group, but is always supported and endorsed by them (Dawson & Daniel, 2010, p. 16). SI does not focus on technical solutions but these may be included (Dawson & Daniel, p. 15). Technical innovations differ from SI in that they refer to products or processes, driven by the economy within specific technology fields, primarily aiming at marketable technical improvements (Hachmeister, 2021). In contrast to technical innovations, SI intro-

duces new social practices or organizational forms and aims to initiate lasting structural change in social systems – often in conjunction with, but not limited to, technological developments (BMWK & BMBF, 2023; Howaldt & Kaletka, 2022). Since many sustainability debates have so far mostly focused primarily on technical innovations, the demarcation is often still blurred and is only increasingly emerging (Borrmann et al., 2022, p. 51).

SI appears highly promising for addressing societal challenges in STEM education. However, it has so far received limited scholarly attention in this context (e.g. Burlison et al., 2021, p. 157; García-Aracil et al., 2024, p. 1490; Niles et al., 2018, p. 1; Toledo Tan et al., 2023, p. 2; Valdes-Ramirez et al., 2024, p. 3). STEM degree programs often focus primarily on technical knowledge and leave out complex, social problems (Niles et al., 2018, p. 1). Consequently, young learners in particular struggle to see the relevance of STEM subjects to the real world and societal needs (Strayhorn et al., 2013, p. 10). In order to reduce this gap, as well as the knowledge action gap mentioned at the beginning, this study advocates the implementation of principles of ESD in the examination of SI in STEM courses. The current research indicates that implementation of ESD principles in STEM remains limited and often lacks practical integration. A systematic review by Banate and Bauyot (2025) highlights that while interdisciplinary STEM education aligns with sustainability goals, its success de-

pends on institutional support, curriculum development, and teacher training (p. 207).

The present analysis applies ESD 2 according to Vare and Scott (2007), which is understood as learning for sustainable development in the form of a collaborative, reflexive learning process (p. 194). Based on that, including ESD creates a win-win situation. ESD supports SI and benefits from it in return. Above all, ESD's action competence, which aims to encourage active and reflective participation in social change, is considered essential (Haan, 1999, p. 271).

The *social innovation summer school* in August 2024 provided an opportunity to test SI based on ESD with STEM students by addressing the following question: What opportunities and challenges arise from addressing SI through an ESD-oriented summer school for STEM students, particularly regarding the potential for active participation in social change? The concept of the summer school and the research methodology are presented below, followed by a discussion of the key findings.

2. Conceptualization, implementation and evaluation of the summer school

Summer schools can be conducted as part of an academic course or as a stand-alone seminar. Their

objectives span a wide range, from acquiring professional skills and career guidance to fostering personal growth (Duwe, 2024; Kitchen et al., 2018, p. 531). Following Collins and Robertson (2003) summer schools should always take a “student-oriented (and) empowering” (p. 330) approach to teaching and learning. Summer schools at TUD (University of Technology Dresden) are typically offered as block courses during the lecture-free period. The *social innovation summer school* was also designed as a three-day block event to enable its implementation as an extracurricular course. This format allowed for an equal emphasis on theoretical and practical content and facilitated their direct integration. Holding the event during the semester break allowed students from different degree courses to take part, thereby facilitating interdisciplinary exchange. The aim of the summer school was to actively engage students with how social change can be shaped in a socially sustainable way. The theoretical part focused on teaching the basics of business model development and the classification of social challenges. The students were tasked with developing a solution to a social challenge in the form of an innovative social business model and presenting it to a jury. The jury was composed of experts and practitioners with experience in SI, interdisciplinary collaboration, and business model development in Dresden and the wider Saxony region.

The target group consisted of students from the School of Engineering Sciences with Mechanical Science and Engineering, Computer Science and Electrical and Computer Engineering, the School of Civil Environment Engineering with Architecture, Civil Engineering, Environmental Sciences, Transport and Traffic Sciences and Business and Economics as well as the School of Sciences with Biology, Chemistry and Food Chemistry, Mathematics, Physics and Psychology. Three of the nine participants were enrolled in business and economics, two in computer science, three in mechanical engineering, and one in water management. Eight participants were female, one male. All students participated voluntarily and submitted a letter of motivation as part of the application process. Since the number of applications remained below capacity, all applicants were accepted. The program did not award ECTS credits. Students who successfully presented their ideas to the jury received a certificate. The offer was financed by equal opportunities funds from the School of Engineering Sciences and specifically addressed female students, as they are often significantly outnumbered in STEM degree programs (proportion of women nationwide: 32.4% (Zandt, 2024), TUD Mechanical Engineering 18%) to offer them a space to contribute their ideas and exchange ideas (Duwe, 2024). The working groups were deliberately composed of students from different academic disciplines to encourage interdisciplinary exchange. This diversity was seen as crucial for integrating multiple perspec-

tives into the development of SI. Interdisciplinary collaboration also empowers students to co-create innovative solutions (James Jacob, 2015, p. 3; Podgórska & Zdonek, 2024, p. 2089; Spelt et al., 2009, p. 366). Schijf et al. (2023, p. 441) argue that such an approach can simultaneously convey knowledge and build practical skills.

2.1 Program

The three days were divided into a theory block in the morning and a practical block in the afternoon. The theoretical information and analysis methods taught in the morning could be applied to the participants' own ideas in group creative sessions in the afternoon. This combination is rated as conducive to learning (Kitchen et al., 2018, p. 532). The process provides students with a toolbox of methods for generating, evaluating and convincingly presenting their own ideas. The speakers for the theoretical input were educators, researchers and company employees from Saxony, Germany. They all passed on their knowledge to the students free of charge and were available to answer questions. The learning content was broadly based in order to tie in with the different prior knowledge and interests of the participants. The following program, which can be seen in Table 1 was created in the form of inputs, lectures, workshops and guidelines.

Day 1: Idea generation	<ul style="list-style-type: none"> • What are social innovations and what is social entrepreneurship? – Examples and criteria • Sustainable Development Goals • What are innovations? – Classification in the innovation process • Transfer and interdisciplinary work • Group formation and competence assessment • Creativity techniques in Design Thinking such as Mind Mapping, Personas, Double Diamond, 6-3-5 Method, Six Thinking Hats and Prototyping (Meinel & Krohn, 2022)
Day 2: Idea evaluation and development	<ul style="list-style-type: none"> • Business model development with the Impact Business Model Canvas (Ebeling & Beha, 2019) using PESTEL, stakeholder, target group, competition, and SWOT analysis • Four pillars of sustainability
Day 3: Idea presentation	<ul style="list-style-type: none"> • Pitch deck creation and pitch presentation to get excited about ideas • Financing models for start-ups

Tab. 1: Program of the social innovation summer school

2.2 Learning outcomes

Inspired by Collins' and Robertson's (2003, p. 327) entrepreneurship education summer school, insights into the innovation and start-up process were defined in advance as learning outcomes. In addition, the development of soft skills such as teamwork and communication skills, solution-oriented and creative work, as well as project management and persuasiveness were promoted (García-Aracil et al., 2024, p. 1480; Schijf et al., 2023, p. 435; Spelt et al., 2009, p. 373). Interdisciplinary networking in the areas of entrepreneurship and the provision of a start-up network were also part of the summer school (Kitchen et al., 2018, p. 531).

2.3 Methodology of the research of the summer school

The data collection is based on a quantitative survey (teaching evaluation) and qualitative focus group discussions, both conducted at the end of the seminar. The focus group discussion method was chosen in order to explore shared experiences and attitudes of the participants in the groups in addition to their individual assessments. Each group (n=3) engaged in a 30-minute discussion, which was recorded, transcribed, and analyzed using qualitative content analysis following Mayring (2022). This method was particularly suitable given the objective of capturing subjective

interpretations, experiences, and perspectives of the participants.

However, several methodological limitations apply. First, the number of participants was very small (n=9), limiting the generalizability of the findings. Furthermore, the qualitative categories were inductively developed based on a very specific sample. Second, participation was voluntary, and a certain bias toward positive feedback cannot be ruled out. Third, it should be noted that the researchers were involved in the design, implementation and evaluation of the program. As a result, the focus group discussions could not take place on a purely professional basis and the students stated that they sometimes felt the pressure of social desirability. At the same time, the established trust between facilitators and participants might have also encouraged openness and reflection.

The interviewees were given three stimuli for the focus group discussion, which are listed in Table 2.

3. Results and discussion

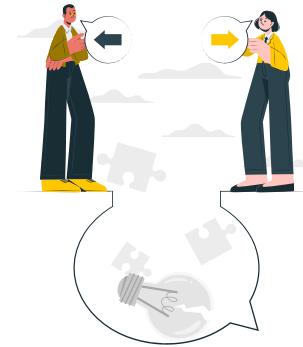
The following section presents the results of the teaching evaluation and focus group discussions. It examines the opportunities and challenges of engaging with SI in the context of an ESD-oriented summer school for STEM students. The aim is to explore how such engagement can strengthen students'

Impulse 1

Impulse 2

Impulse 3

English translation: What five tips would you [group of participants] pass on to a group of students who would also like to develop a social innovation?



Storyset, 2024

“Social innovations inspire us to get stuck in and take responsibility ourselves. They solve problems, establish new solutions and prove that we can make a big difference ourselves.”
– Plattform für Soziale Innovationen & Gemeinwohlorientierte Unternehmen (sigu-plattform, o. J.)

Tab. 2: Impulses for the focus group discussion

active participation in social change. The inadequate examination of SI in the STEM degree programmes identified in Chapter 1 is also evident at TU Dresden. Relevant modules are found almost exclusively outside the STEM disciplines, particularly in the Schools of Medicine and Humanities and Social Sciences. One participant, a mechanical engineering student, expressed a desire to become more aware of how engineering activities and related technological developments affect society. This perspective is supported by recent studies (Lopez-Caudana et al., 2024, p. 5; Orchard & O’Gorman, 2024, p. 15). In contrast Niles et al. (2018, p. 5) argue that understanding the social context and impact of engineering can conflict with

established norms of engineering knowledge and practice.

Five inductively formed categories emerged from the focus group discussions, which are presented below:

1. Assessment and impact of SI
2. Difficulty in differentiating between technical innovation and SI and focusing on monetary or social benefits
3. Interdisciplinary cooperation and gaining interdisciplinary insights
4. Opportunities and challenges as well as methods of collective cooperation
5. Dependence on prior experience in sustainable business model development

Category 1: Assessment and impact of SI

The students' contributions indicate that they effectively addressed the challenges associated with SI during the summer school. They reflected on the effects of social problems and recognized that SI do not necessarily have to address society as a whole. Nevertheless, the students expressed feeling overwhelmed by the multitude of problems and the novelty inherent in innovative approaches. In addition, they also emphasized that it was not the possibility of developing a social business model, but the perception of the social problems themselves that inspired and motivated them to take action. In contrast to this, two participants also noted that SI is not always

positive and may even lead to negative consequences for certain segments of society. This perspective could partly explain the limited motivation to engage more deeply with the content of the summer school, as reflected in the teaching evaluation. The perceived relevance for students' academic studies and future careers was only partially affirmed. One possible reason is a general lack of awareness of SI in their everyday lives, which may lead to a limited sense of urgency or perceived need. In addition, none of the groups saw a concrete problem that could be solved with an SI or expressed a concrete intention to start a business.

Category 2: Difficulty in differentiating between technical innovation and SI and focusing on monetary or social benefits

SI has played a minor role in the students' education to date. Some of the groups were challenged to clearly differentiate between social and technical innovations, even though the definition of SI and the differentiation from technical innovations were discussed in the theoretical part of the summer school. Each group emphasized that based on their experience they would advise other students interested in developing a social business model to begin by defining what is meant by SI. The groups described the defining process as a key challenge, driven by uncertainty about whether a SI must address society as a whole or can target a specific group. Although the theoretical part of the summer school on innovation

processes discussed the difference between inventions as new ideas and innovations as the process of bringing those ideas to market, the students struggled to assess whether the value of their ideas lay in social impact, monetary return, or both. The Impact Business Model Canvas (Ebeling & Beha, 2019) was introduced on the second day of the summer school and applied in a case-based workshop on business model development. Nevertheless, the students had difficulties classifying the value of their idea and developing a suitable business model. These challenges varied depending on the students' prior experience in their respective fields of study. The students seemed to be rather anxious about the idea of entrepreneurship and the implementation of their idea. This assessment of a socially-oriented engineering education is also reflected in the qualitative study by Niles et al. (2018, p. 5).

Category 3: Interdisciplinary cooperation and gaining interdisciplinary insights

Most participants stated in the teaching evaluation that the change of perspective and the exchange with students from other fields of study helped them to develop ideas. They perceived the "exchange", the "personal communication and interaction" and the "diverse group composition" as particularly successful and useful for the group work. The interdisciplinary composition of the groups had different effects in each group. While two groups appeared to engage very positively in interdisciplinary exchange, the third

group was strongly influenced by a single student with a focus on economic aspects, which led to the socially sustainable impact of the innovation being treated as secondary. One participant also explained that when developing the product, she could not assess whether it would “really make a big difference or to what extent it would really be helpful”. To counter this uncertainty, students could be introduced to the co-creation process and the active involvement of users (Kohlgrüber et al., 2021, p. 11), as cooperation with society is considered a central aspect of the SI process (Hirsch et al., 2023, p. 36ff.).

Category 4: Opportunities and challenges as well as methods of collective cooperation

In addition to the predominantly perceived meaningfulness of interdisciplinary cooperation, students also rated collective teamwork positively. Working together on a shared problem was seen as more reflective of real-world professional environments than traditional university settings. The participants stated across the board that they found the open, non-judgmental and interdisciplinary exchange to be conducive to learning. Since they participated in the summer school voluntarily and there were no ECTS credits, they felt less evaluated and had the feeling that they could speak more freely. The students highlighted the added value of involving companies and network platforms as partners in the summer school. In addition, the participation of some of these actors in the jury was rated as particularly meaningful, as it

highlighted points of contact for the real implementation of innovations. While many students already possessed prior knowledge in group organization and project management, the focus group discussion particularly emphasized the relevance of target group and stakeholder analysis, along with the principles of design thinking. The students rated these as conditions for successful innovation, which was also shown in another study (York & Conley, 2020, p. 2999). The Design Thinking approach was taught during the summer school as part of the workshop on competence orientation and group building. The mindset principles (IDEO, 2015, p. 19ff.) were written on the blackboard for the entire three days, visible to everyone in the room. Students particularly highlighted “Learn from failure” and “Iterate” as essential principles. Hölzle (2022, p. 70ff.) emphasizes the meaningful link between Design Thinking and Entrepreneurship Education. Studies show that it is valuable to implement Design Thinking principles in teaching to solve wicked problems (Vignoli et al., 2023, p. 935). For the summer school, the students state that the various creative methods in particular were an important tool for generating ideas. They explicitly mention the “variety of tools provided for generating ideas” as useful and interesting. This has also been observed in other projects for developing solutions to social challenges, such as at the Singapore University of Technology and Design. Design thinking proved to be one of the most important skills in this course (Anariba et al., 2023, p. 5).

Category 5: Dependence on previous experience in sustainable business model development

The dependence on previous experience is a central point of discussion for the students in group collaboration on SI. Some expressed surprise at the extent of business knowledge required for developing a business model, while others were already familiar with the concepts through previous academic projects. In contrast, engaging with socially sustainable content was new to most participants. Only one student reported having encountered the Sustainable Development Goals (SDGs) during high school. Although there could be various possible explanations for these differing levels of prior knowledge, they are not examined in detail in this study.

The results of the evaluation and focus group discussions confirm that students are interested in SI, entrepreneurial action and solving social challenges. The degree of interest depends on prior knowledge and individual interests. The participants consistently expressed their commitment to actively shaping social change in a sustainable manner – ecologically, socially, and economically. As confirmed by the findings of Strayhorn et al. (2013, p. 10) presented at the beginning, students are sometimes quickly overwhelmed by the scale of social problems, the demands of sustainability and the “ground-breaking” idea of innovation. The implementation of ESD in STEM teaching could be an opportunity to show students both subject-specific basics and options

for action. The study by Strayhorn et al. (2013, p. 10) also found that the low relevance of STEM teaching content to the real world sometimes has a demotivating effect. The sense of being overwhelmed by social problems, as expressed by students during the summer school, could potentially be reduced if learners engaged with such issues more frequently and across different subjects. A study on interdisciplinary projects at the Silesian University of Technology confirms this (Podgórska & Zdonek, 2024, p. 2090). The results show that teaching the SDGs in the context of project-based teaching and learning is a way to raise awareness and promote behavior that implements the concept of sustainable development. The students considered sustainable development and its goals both interesting and motivating. According to the authors, this is primarily due to the method's strong practical orientation: students work together with experts from the socio-economic environment of the university to develop solutions for urgent environmental and social challenges (Podgórska & Zdonek, 2024, p. 2099). The summer school followed a similar approach by connecting theoretical input with real-world challenges and involving external experts.

Reflection on workshop facilitation

The main challenges in designing and running the summer school were related to organizational aspects. The implementation depended on one person and one student assistant. In particular, the promotion of the summer school took a surprising amount of time. With a target group of several thousand students, there were very few registrations and some last-minute cancellations despite widespread advertising. In addition, the search for suitable speakers who could be on site at the set time and were willing to share subject-specific knowledge was also a challenge. Most participants and speakers perceived the face-to-face format as unproblematic. Although an online event would facilitate the availability of the speakers, it would also make informal exchange and networking more difficult.

Another key challenge was the fact that there is not yet a strong SI/SE community at TU Dresden. As a result, the organizer had to rely on her network and used it to recruit the various speakers for the summer school. Another obstacle to the continuation and development of the summer school is the fact that its implementation is repeatedly dependent on the approval of third-party funding. A qualitative study on engineering education for sustainable development in Brazil shows that isolated actions have only a short-term effect and are not sufficient to strive for fundamental change (Sigahi & Sznalwar, 2023, p. 5). Since small programs such as the summer school

have a limited reach, they generally do not require support or approval from higher levels of the higher education hierarchy, but they also do not achieve a strategic change in the higher education system (Sigahi & Sznalwar, 2023, p. 9.). In order to actively support SI initiatives and expand their reach, SI must be anchored as a mission of the university (Cunha et al., 2022, p. 401). Other programs such as Maker Spaces (collaborative work environments equipped with tools and technologies for hands-on innovation) also enable the integration of interdisciplinary cooperation to solve social challenges. However, they too often face organizational hurdles at universities, which require institutional support to overcome (Tabarés & Boni, 2023, p. 256f.).

Implications and Outlook

To enable students to engage more effectively with SI, teaching should place stronger emphasis on real-world social challenges and promote a deeper understanding of sustainability in line with the principles of ESD. This is also confirmed by Hirsch et al. (2023, p. 38), who have further developed a teaching program on SI. The focus is no longer on finding solutions, but on discovering problems. Emphasis is placed on equipping students with methods to solve "wicked problems". This approach should also be pursued more when dealing with SI and SE.

The insights from the summer school could support curriculum developers and educators in integrating SI more systematically into STEM programs, where

it has so far received little attention (Peters et al., 2025; Merlin et al., 2023; Hirsch et al., 2023). Scholars in education, entrepreneurship and social sciences could benefit from the summer school teaching format, which offer a transferable model for promoting interdisciplinary learning, social responsibility, and sustainable development in higher education.

The concept of the *social innovation summer school* in STEM should be understood as a starting point for raising awareness and initiating ESD-oriented reflection on social change. The results are based on a limited sample and capture subjective perceptions rather than generalizable data. The insights gained should therefore be understood as indicative impulses for further development of similar formats. Since the qualitative categories were inductively derived from a highly specific sample, the findings are not directly transferable to other contexts. The results can serve as a basis for the design of similar educational experiments aimed at the “inclusion of people, knowledge and practices in defining STEM learning, beyond the disciplinary hegemony of science” (Takeuchi et al., 2020). Furthermore, three days were too short to convey extensive entrepreneurial content and to deal comprehensively with social problems. A more in-depth approach might have helped to alleviate the students’ fears of making the wrong decision regarding the selection and further development of their idea. Merlin et al. (2023, p. 213f.) explain that they have developed and evaluated a master’s degree pro-

gram in “Responsible Entrepreneurship”. This course offers the opportunity to teach content in the sense of ESD and entrepreneurial skills as part of entrepreneurship education (Merlin et al., 2023, p. 212). As the program runs over three semesters, it seems clear that the teaching of SE and, accordingly, probably also of SI content requires significantly more time. The *social innovation summer school* may serve as a source of inspiration for STEM educators, curriculum developers, and professionals involved in higher education for sustainable development by offering interdisciplinary and transdisciplinary learning formats that connect technical disciplines with societal needs (Tabarés & Boni, 2023; Takeuchi et al. 2020). The conclusion of the social innovation summer school in STEM points to the need for further, ideally long-term projects that build on the knowledge gained and focus on strengthening STEM students’ problem-solving skills in addressing social challenges.

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